Renewal Proposal for the Fourth Year and
Performance Report for the Third Year
of the 4-year NASA Grant NAG5-3974 entitled

ADVANCED GLOBAL ATMOSPHERIC GASES EXPERIMENT (AGAGE):

MIT Contribution

Principal Investigator and Grantee Institution

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Attention:

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1-202-358-0237

1. Research Objectives

AGAGE comprises continuous high frequency *in-situ* gas chromatographic FID/ECD measurements of two biogenic/anthropogenic gases (CH_4, N_2O) and five anthropogenic gases ($CFCl_3$, CF_2Cl_2, CH_3CCl_3, $CF_2ClCFCl_2$, CCl_4) which are carried out at five globally distributed sites (Ireland, California, Barbados, Samoa, Tasmania). Also, high frequency *in-situ* gas-chromatographic mass-spectrometric measurements of about 30 species including chlorofluorocarbon replacements and many natural halocarbons are made at two sites (Ireland, Tasmania), and will soon begin at the other three sites. Finally, high frequency *in-situ* gas chromatographic HgO-RD measurements of CO and H_2 are performed at two sites (Ireland, Tasmania). The goal is quantitative determination of the sources, sinks, and circulation of these environmentally important gases.

2. Summary of 1998–2001 Progress and Results

The accomplishments of AGAGE under this grant over the period 1998–2001 have been substantial and are documented in a large number of peer-reviewed publications. The data for the many species measured in AGAGE are generally of high quality and are recorded in public archives. In this section we provide a summary of our research highlights for the past almost three years.

A recent analysis of the entire 1978-2000 ALE-GAGE-AGAGE CH_3CCl_3 data indicate OH levels in the southern hemisphere are higher than in the northern hemisphere and that OH levels rose between 1978 and 1988, and then subsequently decreased to levels in 2000 below 1978 values (Prinn *et al.*, 2001). The 1994-1998 AGAGE $CHCl_3$ measurements have been analyzed showing that this gas has a pronounced seasonal cycle (driven largely by OH), a global average baseline mole fraction of 8.9 ppt with no significant trend, and a global lifetime of 6.3 months. Inverse methods indicate emissions are predominantly (73%) in the 30°N – 90° region (O'Doherty *et al.*, 2001). The doctoral thesis of J. Huang (1999) produced new estimates of OH using CH_3CCl_3, $CHClF_2$, CH_2FCF_3, CH_3CCl_2F and CH_3CF_2Cl, simultaneously. An analysis of the GAGE-AGAGE measurements of CH_4 from 1985 – 1999 indicates a decreasing trend, in agreement with previous independent analyses, and has yielded estimates of CH_4 emissions in each semi-hemisphere (Cunnold *et al.*, 2001). Measurements of CH_3Br from AGAGE and other investigators have been modelled using the 3D Model for Atmospheric Chemistry and Transport (MATCH, Jensen, 1999). A critical analysis of polynomial-based approaches to the CH_3CCl_3 inverse problem has been published (Prinn and Huang, 2001.).

We have reported, and interpreted, AGAGE GC-MD measurements of hydrogen at Cape Grim (Simmonds *et al.*, 2000). GAGE/AGAGE measurements of $CFCl_3$ indicate its global concentrations reached a maximum in 1993 and decayed slightly after that, while CF_2Cl_2 levels continued to increase but only slowly since 1993 (Prinn *et al.*, 2000). A complete description of instrumentation, calibration, and observations over the entire ALE/GAGE/AGAGE experiment together with model-based back-extrapolations has yielded a complete definition of the history of ozone-depleting manmade halocarbons in air (Prinn *et al.*, 2000). Several AGAGE scientists were lead or co-authors in the recently completed 1998 Ozone Assessment (Kurylo *et al.*, 1999; Prinn *et*

al., 1999). Analysis of regional pollution events in Ireland suggest that industry estimates of the rate of decline in European emissions are too small (Derwent *et al.*, 1998a). Measurements of CCl_4 from July 1978 to June 1995 show a maximum in its global concentration in 1990, followed by a small decrease since then (Simmonds *et al.*, 1998a). GC-MS measurements of CF_3CH_2F, CCl_2FCH_3, and CF_2ClCH_3 (HFC-134a; HCFCs 141b and 142b) at Mace Head indicate rapid increases in the levels of these CFC replacements, and that industry estimates of HCFC-141b and particularly HCFC-142b emissions appear far too small to explain the observations (Simmonds *et al.*, 1998b). Measurements of $CHClF_2$ (HCFC-22) in the Cape Grim archive and at La Jolla have been used to estimate OH concentrations and this yields values larger than those determined from CH_3CCl_3 (but due to the larger uncertainty in the HCFC-22 based estimate the difference is not statistically significant; Miller *et al.*, 1998). A lagrangian dispersion model has been used to analyze 1996 Mace Head observations showing North American sources occasionally produce pollution events at this station, which are about 10% of those due to the European sources (Ryall *et al.*, 1998). Mace Head data for CH_4, N_2O, and CO_2 have been analyzed to elucidate European and northern-hemispheric sources (Derwent *et al.*, 1998b). Cohan *et al.*, (2001) have reported AGAGE CH_3I measurements at Cape Grim and interpreted them using trajectory analysis. Dunse *et al.*, (2001) report the results of modelling studies of Cape Grim pollution episodes recorded in AGAGE measurements.

The AGAGE instruments for the measurement of CCl_3F, CCl_2F_2, CCl_2FCClF_2, $CHCl_3$, CH_3CCl_3, CCl_4, N_2O and CH_4 at the five AGAGE clean air measurement sites and the Scripps Institution of Oceanography (SIO) calibration laboratory and measurement site continued to operate with unprecedented precision, frequency and reliability throughout the past three years. Also, the first and second AGAGE GC-MS systems, prepared at Bristol University and installed at Mace Head and Cape Grim Tasmania, are operating successfully. A third system at Bristol University is being used to prepare new standards for the GC-MS gases. The SIO group, working with the Bristol group, has developed a new generation of cryo-trapping and injection techniques (MEDUSA) for improved GC-MS accuracy and calibration versatility. The MEDUSA systems are now being installed at the relevant stations. AGAGE primary calibration work has continued to advance, with the completion of the more accurate SIO-1998 calibration scale. This has included all of the halocarbon compounds analyzed by the AGAGE multi-detector GC system, as well as a new primary N_2O standard which is free of the contaminants which biased the earlier SIO-1993 halocarbon calibrations. SIO is continuing its calibration work on selected compounds measured by GC-MS and by oxygen-doped ECD, including $CHClF_2$, CH_3Br, CH_3Cl and SF_6, and is continuing to participate actively in intercalibration exercises with other laboratories. The entire ALE/GAGE/AGAGE GC-ECD data base, comprising every calibrated measurement including pollution events from June 1978 through March 2000, is publicly accessible at the Carbon Dioxide Information and Analysis Center (CDIAC) at the U.S. Department of Energy, Oak Ridge National Laboratory, through the Internet [http://cdiac.esd.ornl.gov/ndps/alegage.html].

3. 1998–2001 Publications

Cohan, D. S., G. A. Sturrock, A. P. Biazar, M. L. Cox, and P. J. Fraser, Methyl Iodide observations at Cape Grim, Tasmania using the AGAGE GC-MS Instrument, *J. Atmos. Chem.,* submitted, 2001.

Cunnold, D. M., L. P. Steele, P. J. Fraser, P. G. Simmonds, R. G. Prinn, R. F. Weiss, L. W. Porter, R. L. Langenfelds, P. B. Krummel, H. J. Wang, L. Emmons, X. X. Tie, and E. J. Dlugokencky, GAGE/AGAGE measurements of methane at five sites from 1985–1999 and source inferences there from, *J. Geophys. Res.,* in press, 2001.

Derwent, R., P. G. Simmonds, S. O'Doherty, and D. Ryall, The impact of the Montreal Protocol on halocarbon concentrations in northern hemisphere baseline and European air masses at Mace Head Ireland from 1987–1996, *Atmos. Environ.*, **32**(21), 3689–3702, 1998a.

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Dunse, B. L., L. P. Steele, P. J. Fraser, and S. R. Wilson, An analysis of Melbourne pollution episodes observed at Cape Grim from 1995–1998, *Baseline 97–98*, CSIRO-DAR and Bureau Meteorology, Aspendale, Australia, pp. 34–42, 2001.

Fraser, P. J., D. Oran, C. Reeves, S. Penkett, and A. McCulloch, Southern hemispheric halon trends (1978–1998) and global halon emissions, *J. Geophys. Res.*, **104**, 15985–15999, 1999.

Fraser, P. J. and M. J. Prather, An uncertain road—the science of atmospheric recovery, *Nature*, **398**, 663–664, 1999.

Huang, J., Optimal determination of global tropospheric OH concentrations using multiple trace gases, Ph.D. thesis, MIT, 163 pgs, 1999.

Jensen, C., Terrestrial sources and sinks of atmospheric methyl bromide: Three-dimensional modeling of tropospheric abundance and sensitivities, M.S. thesis, MIT Center for Global Change Science Report 62, 41 pgs., 1999.

Kurylo, M. J., J. M. Rodriguez, M. O. Andreae, E. L. Atlas, D. R. Blake, J. H. Butler, S. Lal, D. J. Lary, P. M. Midgley, S. A. Montzka, P. C. Novelli, C. E. Reeves, P. G. Simmonds, L. P. Steele, W. T. Sturges, R. F. Weiss and Y. Yokouchi, Short-Lived Ozone-Related Compounds. Chapter 2 in: *Scientific Assessment of Ozone Depletion: 1998*. World Meteorological Organization, Global Ozone Research and Monitoring Project, Report 44, Geneva, pgs. 2.1-2.56, 1999.

Miller, B. R., J. Huang, R. F. Weiss, R. G. Prinn, and P. J. Fraser, Atmospheric trend and lifetime of chlorodifluoromethane (HCFC-22) and the global tropospheric OH concentration, *J. Geophys. Res.*, **103**, 13237–13248, 1998.

Miller, B. R., Abundances and Trends of Atmospheric Chlorodifluoromethane and Bromomethane, Ph.D. Thesis, University of California, San Diego, 149 pp., 1998.

O'Doherty, S., P. Simmonds, D. Cunnold, R. H. J. Wang, G. A. Sturrock, P. J. Fraser, D. Ryall, R. G. Derwent, R. F. Weiss, P. Salameh, B. R. Miller, and R. G. Prinn, In Situ Chloroform

Measurements at AGAGE Atmospheric Research Stations from 1994–1998, *J. Geophys. Res.*, **106**, 20429–20444, 2001

Prinn, R.. G. and J. Huang, Comment on "Global OH trend inferred from methylchloroform measurements" by M. Krol *et al., J. Geophys. Res.*, **106**, 23151–23158, 2001.

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Prinn, R. G., R. Zander, D. M. Cunnold, J. W. Elkins, A. Engel, P. J. Fraser, M. R. Gunson, M. K. W. Ko, E. Mahieu, P. M. Midgley, J. M. Russell III, C. M. Volk and R. F. Weiss, Long-Lived Ozone-Related Compounds. Chapter 1 in: *Scientific Assessment of Ozone Depletion: 1998.* World Meteorological Organization, Global Ozone Research and Monitoring Project, Report 44, Geneva, pgs. 1.1-1.54, 1999.

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Simmonds, P. G., R. G. Derwent, S. O'Doherty, D. B. Ryall, L. P. Steele, R. J. Langenfelds, P. Salameh, H. J. Wang, C. H. Dimmer, and L. E. Hudson, Continuous high frequency observations of hydrogen at the Mace Head baseline atmospheric monitoring station over the 1994–1998 period, *J. Geophys. Res.*, **105**, 12105–12121, 2000.

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Simmonds, P. G., J. Huang, R. Prinn, S. O'Doherty, R. Derwent, D. Ryall, G. Nickless, and D. Cunnold, Calculated trends and atmospheric abundance of 1,1,1,2-tetrafluoroethane, 1,1-dichloro-1-fluoroethane, and 1-chloro-1,1-fluoroethane using automated *in-situ* gas chromatography-mass spectrometry measurements recorded at Mace Head, Ireland from October 1994 to March 1997, *J. Geophys. Res.*, **103**, 16029–16037, 1998b.

Walker, S. J., R. F. Weiss and P. K. Salameh, Reconstructed histories of the annual mean atmospheric mole fractions for the halocarbons CFC-11, CFC-12, CFC-113 and carbon tetrachloride, *J. Geophys. Res.*, **105**, 14285-14296, 2000.

Wamsley, P., P. Fraser, P. Steele, M. Lucarelli *et al.*, Distribution of halon-1211 ($CBrClF_2$) in the upper troposphere and lower stratosphere and the 1994 bromine budget, *J. Geophys. Res.*, **103**, 1513–1526, 1998.

4. Work Proposed for Fourth Year

The fourth year includes the following major tasks by MIT and its subcontractors:

1. Overall leadership and coordination of AGAGE which currently consists of the AGAGE multi-detector-GC instrumentation at the five AGAGE sites and the AGAGE GC-MS instruments at Mace Head, Ireland and Cape Grim, Tasmania.
2. The purchase of a new GC-MS for Cape Matatula, Samoa (using funds requested in this fourth year budget). Note that the GC-MS instrument previously purchased with year two funds is being installed at Trinidad Head, CA, and that the GC-MS currently at Bristol University will go to Barbados once its use for calibration is completed.
3. Partial support for operation of the Tasmania, Barbados, and Ireland AGAGE stations.
4. Analysis of the data using improved 2-D and 3-D models for solving inverse problems to obtain emissions and lifetimes from the data.
5. Publication of the results and public archiving of the data.

The fourth year also includes the following major tasks to be carried out by SIO under its two separate grants for AGAGE laboratory and field station work:

1. Support of the overall AGAGE multi-detector-GC instrumentation network with respect to instrument performance, maintenance and quality control standards, including software and network data processing for all the AGAGE field data.
2. Primary and secondary calibration of the AGAGE multi-detector-GC measurements and a selected subset of AGAGE GC-MS measurements, including preparation of primary gravimetric standards and distribution of calibrated compressed air secondary working standards to all the stations.
3. Operation of the Cape Matatula, Samoa, and Trinidad Head, California, AGAGE stations.
4. Sequential installation at each station of new MEDUSA hardware (in collaboration with Bristol University) and software for the next generation of AGAGE automated GC-MS instrument systems with improved dynamic range, improved calibration capability, and added perfluorocarbon measurements.

The budgets also include two AGAGE science team meetings for the fourth year. These meetings in which the instrument performance and data over the previous half year are carefully reviewed, technical problems and remedies are discussed among the investigators, and theoretical analyses and draft publications are planned and reviewed by the entire team, have been an essential element in the successful running of ALE, GAGE, and AGAGE. Also, representatives from NASA Headquarters, industry (AFEAS), and NOAA (CMDL) regularly attend these meetings. Meetings are usually planned to be close to or at one of the AGAGE stations or at SIO, MIT, GaTech or U. Bristol. In this way, the relevant station scientists can usually combine the meeting with their scheduled station servicing trips, and the travel burden is spread reasonably among the AGAGE team members.

Routine operations of the Cape Grim, Tasmania station are funded by Australia (CSIRO, Bureau of Meteorology), routine operations of the Mace Head, Ireland station are funded by the United Kingdom (Department of Environment, Transport and the Regions), and NOAA supports approximately 50% of the routine operations at Ragged Point, Barbados. Also, the new GC-MS system being used for absolute calibration work at Scripps Institution of Oceanography is fully funded by that institution. Finally, development costs for the models used in theoretical analysis are supported largely by other NASA, EPA, DOE and NSF grants. Thus the funds requested here for AGAGE from NASA will (as in the past) be leveraged significantly by contributions from other federal agencies and other countries.

The following pages contain the fourth year budgets for our respective institutions. For MIT these include subcontracts to Georgia Institute of Technology (GIT), International Science Consultants-Bristol University (INSCON), and Commonwealth Scientific and Industrial Research Organization (CSIRO).

5. Year 4 of 4 AGAGE Budget: January 1, 2002 to December 31, 2002

Budget Notes

Salaries & Wages:

Professor Prinn is supported at MIT principally through the TEPCO professorship and his Department Head appointment. Support is requested here from NASA for 0.25 months only.

Dr. Jin Huang and a Graduate Research Assistant will aid in the application of mathematical inverse methods to analyze AGAGE data using 2D and 3D chemical transport models.

The administrative staff will manage accounting issues, extensive travel arrangements, subcontract issues, and preparation of publications for the project.

Graduate Research Assistant support consists of $21,600 for salary (subject to F&A, but not employee benefits or vacation accrual). MIT subsidizes the $26,960 annual tuition by 65%, for a total cost to the project of $9,436 (not subject to F&A).

Travel: 2002

NASA-NDSC meeting, Toronto, Canada: Estimated costs: airfare $500; 5 days subsistence $875; ground transportation $225.

AGAGE meeting in La Jolla, CA: Estimated costs for trip: airfare $1,200, 5 days subsistence $1,050; ground transportation $300.

AGAGE meeting in Samoa: Estimated costs for trip: airfare $3,000; 5 days subsistence $1,250; ground transportation $300.

Materials & Services: We estimate requiring 100 CUs each year on the NASA/NCCS computers mainly for 3D model use in AGAGE data analysis by inverse methods.

Year Four of Four AGAGE Budget NASA Grant # NAG5-3974
January 1, 2002 to December 31, 2002

	Months/Year	
Salary & Wages		
Prof. R. Prinn (summer month, 2002)	0.25	3,938
Dr. Jin Huang, Research Scientist	6.00	21,322
Graduate Student	12.00	21,600
Admin. Support Staff, F. Goldstein & R. Hanlon @ 10% of 12 mos	2.40	19,583
Total Salaries & Wages		$66,443
Benefits	*Rate*	
Employee Benefits (RA's excluded from EB)	18.0%	8,072
Vacation Accrual (RA's, faculty salaries excluded)	9.5%	3,886
Total Benefits		11,958
Total Salaries and Benefits:		**$78,401**
Travel		
Domestic		
AGAGE Meeting, La Jolla, CA 2002		2,550
Total Domestic Travel:		2,550
Foreign		
NASA-NDSC meeting Toronto 2002		1,600
AGAGE Meeting Samoa 2002		4,550
Total Foreign Travel:		6,150
Total All Travel:		**8,700**
Materials & Services		
Telephones, NASA/NCCS access, xeroxing, office supplies, etc.		2,631
Computer plus software upgrades and peripherals		2,000
Publications: JGR ($165/page)		3,500
Total Materials & Services:		**8,131**
Other Costs: (excluded from F&A)		
Permanent Equipment		
Purchase & Installation of GC-MS Instrument for Samoa Station		**110,000**
Tution		
Research Assistant Tuition (65% subsidized) $26,960 x35%		**9,436**
Total Direct Costs:		
Modified Total Direct Costs:	$95,231.24	
Facilities & Administrative Costs:		
65.5% current & projected rate	62,376.46	
Total Facilities & Administrative:		**$62,376**
Total MIT Internal		**$277,044**
Subcontracts (no O/H)		
INSCON (see Appendix I)		111,970
GaTech (see Appendix II)		154,701
CSIRO (see Appendix III)		30,500
MIT Summary Total		**$574,215**

APPENDIX I

SUBCONTRACT to International Science Consultants (**INSCON**)

This budget provides partial support for the AGAGE operations at the Barbados and Irish stations under the supervision of Dr. Peter G. Simmonds, International Science Consultants (INSCON), 39 Avon Castle Drive, Ringwood, Hants, BH24-2BB, United Kingdom.

STATEMENT OF WORK (January 1st, 2002-December 31st, 2002)

(1). International Science Consultants (INSCON) will provide all of the manpower, facilities, consumables, and equipment for continuous operation of the AGAGE stations at Ragged Point, Barbados (Approx. 50% funded by this contract), and Mace Head, Ireland (partially funded by this contract). This will include a daily technician visit to provide regular logistical support, and routine maintenance of the station.

(2). Site visits will be performed at approximately 4- monthly intervals for detailed servicing, repairs, and intercalibrations of the AGAGE instruments.

(3). Data will be determined from repetitive 20-minute measurements with a target precision of better than 1.0% for the following trace gases, $CFCl_3$, CF_2Cl_2, $CF_2ClCFCl_2$, CHCl3, CH_3CCl_3, and CCl_4; and with a target precision of better than 0.5% for N_2O, and CH_4. Calibration measurements will be obtained every alternate 20 minutes from secondary reference calibration standards maintained at the station and supplied by Scripps Institution of Oceanography. Each secondary calibration standard will be used at the station, for approximately 6-12 months before being returned to Scripps for re-calibration against the AGAGE primary standards.

(4). All raw chromatographic data, in the form of peak heights (and/or peak areas) for all measured species will be submitted to the AGAGE database at Georgia Institute of Technology for detailed statistical processing. The accumulated database will be used for the preparation and submission of research papers to appropriate scientific journals, and for presentations at various scientific meetings.

(5). Dr Simmonds and/or Dr O'Doherty will attend all of the regular 6-monthly AGAGE project meetings, and maintain regular and close contacts with other members of the AGAGE team.

(6). Dr Simmonds will act as the Project scientist for the collaborative research program at Bristol University (partially funded by the UK DEFRA) to operate an automated GC-MS instrument for high frequency measurements of the HCFCs and HFCs at the atmospheric research station at Mace Head, Ireland. INSCON will provide all of the facilities, and materials to operate the GC-MS instrument at Mace Head, and Mr Gerry Spain has been employed as a full-time station manager.

(7). Secondary field standards of the HFCs will be prepared at Bristol and periodically intercalibrated with absolute measurements at the Scripps Institution of Oceanography. INSCON will also be responsible for archiving the database at Bristol University.

(8). INSCON will also provide technical and calibration support of GC-MS operations and standards for the Cape Grim GC-MS instrument maintained by CSIRO.

INTERNATIONAL SCIENCE CONSULTANTS
BUDGET PERIOD: January 1st, 2002 - December 31st, 2002

Partial Support of The Barbados Station	
1. SALARY & WAGES	
Dr P Simmonds.	16,000.00
Station caretaker	3,760.00
Secretary.	760.00
	20,520.00
Overhead & Admin. Costs (32%)	6,566.00
	27,086.00
2. STATION SUPPLIES & SERVICES	
Supplies and consumables.	6,230.00
Building maintenance.	470.00
	6,700.00
3. MATERIALS & SERVICES	6300.00
4. TRAVEL	
Site visits to Ragged Point, Barbados	
Includes airfare; hotel; rental car, etc.	10,500.00
Local travel in U.K.	300.00
	10,800.00
Barbados Station BUDGET TOTALS.	**$ 50,886.00**

Partial Support Of The GC-MS Field Experiment At Mace Head, Ireland	
1. SALARY & WAGES	
Dr S O'Doherty	22,780.00
Dr P Simmonds	2,920.00
	25,700.00
Overhead & Admin. Costs (32%)	8,224.00
	33,924.00
2. STATION SUPPLIES & SERVICES	
Carrier gases and MS consumables	7,600.00
Freight & shipping costs	800.00
Computer supplies	700.00
Rent & utilities	4,600.00
MS spare parts	2,900.00
Calibration gases	1,300.00
	17,900.00
3. MATERIALS & SERVICES	5,600.00
4. TRAVEL	
Service visits to Mace Head, Ireland	
Includes airfare; hotel; rental car, etc.	3,400.00
Local travel in U.K.	260.00
	3,660.00
Mace Head Station BUDGET TOTALS.	**$61,084.00**

APPENDIX II

SUBCONTRACT to Georgia Institute of Technology **(GA-Tech)**

Budget Period: January 1, 2002 – December 31, 2002

Salaries & Wages		
Professional Services		
Dr. D. Cunnold, Professor – 1 month	11540*	
Dr. Ray Wang, Research Scientist II – 5 months	26545	
Dr. Jinlong Li, Post-doc – 6 months	16158	
M. Keever, Computer Systems Specialist ~ 1 month	6000	
K. Plummer, Administrative Assistant	3381	
Subtotal Professional Services		**$63,624**
Benefits (24.1% of Professional Services)	15334	
1 Research Assistant – 6 months	9000	
Total Salaries & Wages		**$87,958**
Materials, Operating Expense & Supplies and Publication Costs	3000	
Travel (2 trips for 2 persons to AGAGE meetings in Samoa and LaJolla and 1 additional trip for Dr. Cunnold as co-convenor of the Global Emissions Activity of IGAC)	11000	
Total Direct Costs		**$101,958**
Indirect Costs (49.7% of Total Direct Costs)	50673	
Graduate Student Fees	2070	
Grand Total		**$154,701**

*Current salaries have been increased by 1% for anticipated salary increases in calendar year 2002.

Statement of work for AGAGE activities at Georgia Tech for 2002

The Georgia Tech activities are all performed under the supervision of Dr. Cunnold. We will continue to be responsible for processing all the AGAGE data into presentation and archivable form, for identifying and marking regional pollution effects, for maintenance and design of the AGAGE web site for data access, and for submitting the data to the CDIAC and other archives for assessments of data quality. These tasks are primarily the responsibility of Dr. Ray Wang.

Dr. Cunnold, with help from Dr. Jinlong Li and a graduate student, will continue the analysis and modeling of the AGAGE data set. The emphasis will be on emission information which is derivable from the data. In particular Dr. Li will be examining the regional pollution events, including long term changes, via species correlations and calculated trajectories. His emphasis initially will be on Trinidad Head which is the one site with significant pollution which has not previously been examined in this way. Dr. Cunnold will continue his modeling activities and analysis on long term changes in emissions; he will in particular look into N_2O changes and GCMS species which have not yet been examined in detail. We have recently shown that accurate estimates of global average mole fractions may be obtained from the measurements at the 2 GCMS sites of Mace Head and Cape Grim.

APPENDIX III

SUBCONTRACT to Commonwealth Scientific & Industrial Research Organization, Australia (**CSIRO**)

This budget provides partial support for the Cape Grim Baseline Air Pollution Station (CGBAPS) AGAGE operations and international travel for CSIRO/CGBAPS personnel under the supervision of Dr. Paul Fraser, CSIRO Atmospheric Research, Aspendale, Victoria, Australia 3195.

Year 4 of 4, Budget Period: January 1, 2002 - December 31, 2002

INTERNATIONAL TRAVEL[1]	6,500
TECHNICAL OFFICER[2] (5 months includes 33% overhead)	24,000
TOTAL	30,500

Notes

1. The Australian AGAGE team are Dr P. Fraser (CSIRO), N. Derek (CSIRO), P. Krummel (CSIRO), C. McCulloch (CSIRO), Dr P. Steele (CSIRO) and L. Porter (CGBAPS). In this current four-year cycle of AGAGE, there are eight AGAGE meetings: two associated with the UK-AGAGE (Barbados-2000, Ireland-2001) operation, four with the USA-AGAGE (California-1999, Hawaii-2000, Georgia, Massachusetts), and two with the Australia-AGAGE (Victoria-1999, New Zealand-2001). At least two Australian investigators will attend each non-Australian AGAGE meeting and all CSIRO/CGBAPS staff involved in the AGAGE program will attend the Australian AGAGE meetings. Either Fraser or Steele will attend each overseas AGAGE meeting (if possible). The budget above is based on two Australian participants in each international meeting, with an average airfares and subsistence per person per meeting of $2700 and $550 respectively. Any additional travel costs (beyond $6500) in 2002 will be met by CSIRO/CGBAPS.

2. The Technical Officer will maintain, operate and modify (when necessary, under AGAGE direction) the AGAGE systems at Cape Grim, Tasmania. The AGAGE operation at Cape Grim comprises three instrumental facilities: (i) the AGAGE GC-ECD/FID/MRD system for analysis of CFCs, chloroform, methyl chloroform, carbon tetrachloride, nitrous oxide, methane, carbon monoxide and hydrogen (10 species), (ii) the AGAGE GC-MS system for HCFCs, HFCs, minor CFCs, halons and methyl halides (20+ species) and (iii) the AGAGE GC-ECD system for analysis of sulfur hexafluoride. Currently, L. Porter, Senior Technical Officer, is deployed part-time (20%) to maintain and operate the AGAGE systems, with additional assistance from the Officer-in-Charge (Dr N. Tindale, CGBAPS) and technical assistant (C. McCulloch). L. Porter is also responsible for AGAGE data quality assessment and analysis. P. Fraser, N. Derek, P. Krummel and P. Steele are involved in AGAGE data quality assessment, analysis and interpretation.